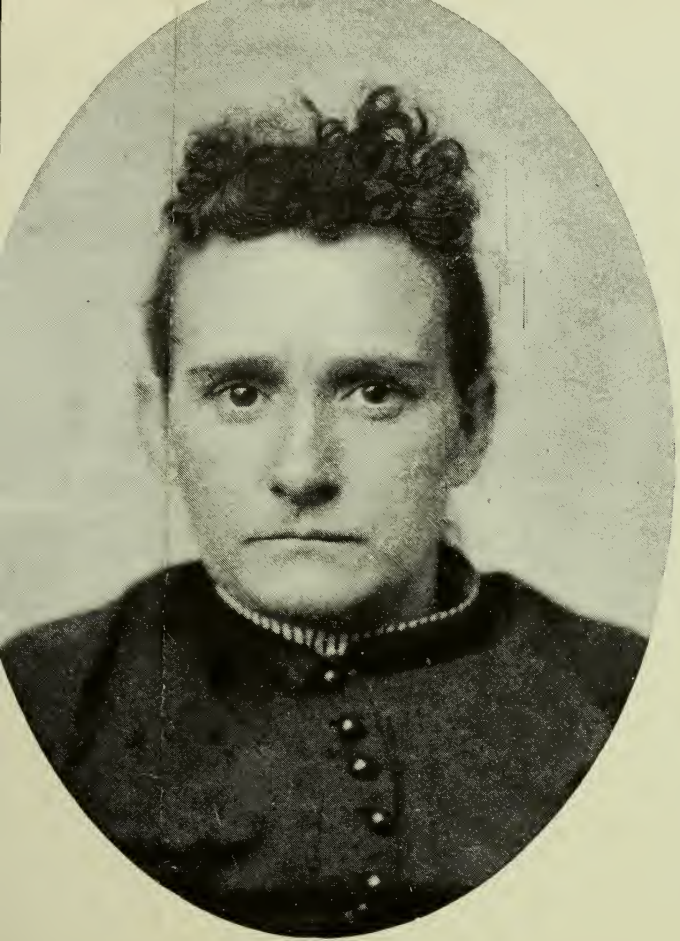

Before Operation.

One Week After Operation.

Case of chronic Cephalalgia and Neurasthenia, treated by graduated tenotomy; (from untouched negatives.) For the history, see page 10.

GRADUATED TENOTOMY

IN THE

TREATMENT OF INSUFFICIENCIES OF THE OCULAR MUSCLES.

(STEVENS'S OPERATION.)

BY

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GRADUATED TENOTOMY IN THE TREATMENT OF INSUFFICIENCIES OF THE OCULAR MUSCLES. (STEVENS'S OPERATION.)

By CHARLES HERMON THOMAS, M.D.

[Read March 14, 1888.]

The study of disorders of the ocular muscles in relation to functional nervous diseases has received a strong forward impetus during the past year, chiefly due to the published results of the labors in this direction of Dr. George T. Stevens, of New York, whose work on *Functional Nervous Diseases*, recently published,[1] has challenged special attention, even where it has not met with entire approval.

The subject occupies a standpoint on the line between the two important specialties of ophthalmology and neurology, it takes somewhat from both, and has already, by force of circumstances, become in a certain sense a specialty by itself.

The operation and its application have, until recently, remained to a remarkable degree personal in the hands of Dr. Stevens, notwithstanding that for many years he has reported it before medical societies and in the medical journals.[2]

All this, however, has been recently changed by the publication, within the last year, of his work above referred to, which has brought the method into such prominent notice as to compel recognition.

Other operators have now entered the field, among whom is Prof. A. L. Ranney, of New York City, who, as a neurological specialist, has reported[3] a series of cases of the gravest neuroses successfully treated by the Stevens' method.

Beyond question a point has now been reached which shows the subject to be worthy of the most sincere investigation.

[1] D. Appleton & Co., N. Y., 1887.

[2] See articles by Dr. George T. Stevens, on "Chorea" (Medical Record, 1876), on "Anomalies of the Ocular Muscles" (Archives of Ophthalmology, June, 1877).

[3] "The Treatment of Functional Nervous Diseases by the Relief of Eye Strain," New York Medica Journal, January 7, 1888.

What I have to present to-night is, to a certain extent, in the nature of a preliminary report; as my work is necessarily incomplete in some particulars, owing chiefly to the considerable length of time required for observation to arrive at a just estimate of the permanency of the results obtained—especially in the gravest and, therefore, most important cases.

I shall attempt to add little that is new to the presentation of the case as made by Dr. Stevens himself, and I cannot hope, in the length of time allotted for its consideration, to make a statement commensurate with its importance, but I have thought it right to rehearse briefly its principal features and to give my own experience in connection therewith, together with a sketch of a few of my own cases; because I have become convinced of the importance of the subject, and also because it has not, heretofore, been brought before this Society,—nor, so far as I can learn, before any other of the medical societies of Philadelphia.

It is now about ten years ago that the operation was first brought to my notice by patients who had been under Dr. Stevens's care. It seemed to me incredible that results such as they claimed were produced in their cases could have been derived from the cause assigned. Again, I questioned the practicability of performing the operation in the definitely graduated manner which was said to be practised by him. Under these circumstances, and in the absence of better information, my position was for a long time one of earnest opposition to the practice in question.

About three years ago, however, having under my care several cases of muscular asthenopia which I was unable to relieve, though I obtained the advice of several of the best known ophthalmologists, and being freshly reminded of the work of Dr. Stevens by a patient of unusual intelligence and reliability, who reported great relief obtained at his hands, I asked his assistance in the treatment of these cases. He kindly demonstrated to me, upon patients of his own, the practicability of the operation, and I became convinced of its great value. The results obtained were so satisfactory that since that time I have investigated the muscular as thoroughly as the refractive conditions in all cases coming under my care, and have as faithfully undertaken to correct them.

For the discovery of abnormality in any of the straight muscles, their physiological condition, both while at rest and in action, and in all states of the accommodation of the eye, must be thoroughly under-

stood. In order that binocular vision may result, the visual lines of both eyes must converge upon the same point, whatever may be the position and distance of the object. It is only under such circumstances that the rays of light are brought to a focus at corresponding points upon both retinæ. A slight deviation results in diplopia, constituting strabismus, a subject sufficiently well understood, and to which Stevens's researches do not directly apply. But while there may be perfect binocular vision, and not the slightest indication of strabismus, there may be, nevertheless, grave faults affecting the recti. It is these faults that Dr. Stevens has emphasized, and to these his observations have been chiefly confined.

In the normal condition of the ocular muscles the visual lines of both eyes naturally preserve an almost exactly parallel direction when looking at distant objects; and they maintain such a position of their own accord from muscular tonicity alone, without the necessity of any additional stimulus. This can be shown by prismatic tests. The artificial diplopia produced in making the test will be such that the two images will lie in that plane which is at right angles to the base of the prism.[1] If, for example, diplopia be induced by a prism placed before either eye with its base directed either outward or inward, the two images will lie in the same *horizontal* plane; and, similarly, *vertical* prisms, with base up or down, will induce diplopia; but in this case the two images will be situated in the same *vertical* plane. The reason for this is because the normal visual lines of both eyes naturally lie in the same *horizontal* and *vertical* planes, even when the powerful stimulus which the need of binocular vision presents is abolished by the prism. Hence, if the eyes in the normal state be directed to a distant object, binocular vision will occur without the need of extra muscular action to bring the visual lines to properly bear upon the object. If, on the other hand, the visual lines of the two eyes do not naturally take the proper position, one of two things will result, either there will be no effort to bring them into correspondence, and strabismus with attending diplopia occurs, or, *more frequently*, by an extra nervo-muscular effort, called into action by the demand for binocular vision, the proper position will be maintained; just as in facultative hypermetropia accommodation is necessary, even when parallel rays coming from a distant object are to be brought to a focus upon the retina. From this forced, though it may be involuntary

[1] Not that Dr. Stevens was by any means the first to employ prisms for the discovery of muscular irregularities, but he appears to have used them with greater precision and by more systematic methods than have heretofore prevailed.

or even unconscious effort to maintain the proper direction of the visual lines, the abnormal conditions under consideration result. We have abundant clinical evidence of the enormous expenditure of nerve force under these circumstances, and of the development of marked reflex disturbances, which are manifested both in symptoms of irritation and of exhaustion.

Dr. Stevens has[1] introduced a series of terms descriptive of the various abnormalities to which the recti muscles are subject. The word *exophoria* designates simply an outward tendency of the visual lines, without implying anything as to which muscle or set of muscles is at fault. The opposite condition, namely, tendency to convergence, is designated by the word *esophoria*, meaning an inward tending.

If either visual line deviates above its fellow, the fact is expressed by the term *hyperphoria*, right or left, as the case may be, always remembering that the lower image represents the higher-tending visual line. It is to be remarked that the condition of hyperphoria is far more frequently productive of serious reflex disturbances than any other fault, and mainly for the reason that a small amount of deficiency in this direction may, and usually does, involve a considerable proportion of the total coördinating power of the vertical muscles; and this because the power of sursumduction is usually limited to about three degrees, while that of abduction is about eight degrees, and that of adduction may be fifty degrees and upward.

The generic term to express any deviation whatever from *orthophoria*, the normal, is *heterophoria*.

Finally, the amount of heterophoria found in any given case is equivalent to and expressed by the degree of the prism required to correct the fault.

In practice, the tests for insufficiency are made by placing prisms before the eyes with their bases in certain definite directions. Lateral diplopia is produced by a prism with base in, vertical diplopia by a prism either up or down. If in lateral diplopia so induced, either image is above the plane of its fellow, we know that the higher image belongs to the eye whose visual line is lowest, to be expressed as hyperphoria of the opposite eye. If, in induced vertical diplopia, either image deviates from the vertical, we have lateral fault—esophoria if the diplopia be homonymous, exophoria if crossed.

In applying the prism test for the discovery of muscular anomalies it is not sufficient to be content with the results of a single or even

[1] "A System of Terms relating to the Conditions of the Ocular Muscles known as 'Insufficiencies,'" by George T. Stevens, M.D., Ph.D. (New York Medical Journal, December 4, 1886).

several examinations, because we must always bear in mind the possibility of latency—that is to say, like latent hyperopia, the true fault may be concealed or masked. Indeed, as in latent hypermetropia we sometimes have apparent myopia through spasm of the muscle of accommodation, so in actual esophoria an apparent exophoria may be manifest, the result of spasm of the externi, and this is equally true of the other muscles. It is only by a careful consideration of all the circumstances, such as the degrees of abductive and adductive power; and, finally, by the use of temporary correcting prisms for whatever fault may be manifested, and following it up—but not leading it—as it develops, by a new correcting prism until the fault becomes stationary, that we are justified in proceeding to operation. In one obstinate case of exophoria I have several times obtained relaxation of spasm of the interni by a moderate dose of morphia administered hypodermically. But, though the after-results proved the observation under morphia to be expressive of the true condition in this case, there are obvious objections to the use of the drug as a matter of ordinary practice. The discovery of an efficient and safe agent for the relaxation of spasm of the recti muscles is greatly to be desired.

It sometimes happens that muscular anomalies of considerable degree are discovered in connection with refractive faults. By correcting the refractive error first not infrequently the muscular difficulty soon disappears, showing the muscular to have been dependent upon the refractive state. The correction of refractive errors, especially those of a hypermetropic character should always be made before applying the prismatic tests.

Defects of refraction and accommodation are well known as the source of serious reflexes, especially headaches or severe migraine, nausea and dizziness; but it is not so well known that defects of muscular adjustment through faults of the guiding muscles of the eye produce all these and many more serious results besides.

From Dr. Stevens I quote:[1]

"Respecting the importance to be attributed to ocular, refractive, and muscular anomalies, I fear that my views will for some time to come continue to be regarded as something more than radical; but I am ready to reaffirm the proposition made years ago, that, among the various elements constituting the neuropathic tendency, these anomalies must be regarded as occupying a preëminent position.

[1] See "Ocular Irritations and Nervous Disorders," by Dr. George F. Stevens. N. Y. Medical Journal, April 16, 1887.

"Summing up the experience in this field of work, it is shown that, not in occasional and rare instances only, but in a large proportion of cases of the most redoubtable neuroses, unusual and most salutary results may be anticipated from attention directed to visual troubles."

Among the neuroses shown in many cases to be dependent upon such troubles, are to be mentioned neuralgia, spinal irritation and neurasthenia, chorea, epilepsy, and mental disorders. Dr. Stevens further says:

"Not only are those painful or irregular conditions usually described as neuroses in great proportion responsive to the relief from ocular tensions, but a great variety of conditions commonly regarded as local affections yield as readily, and prove that with some possible local complications they are, in fact, reflex phenomena. As an instance of this class of trouble, I may mention the fact that in more than a score of cases of extreme dysmenorrhœa —in each of which the periodical suffering has been of intense character, of regular occurrence, and of the full duration of the menstrual life of the patient —the dysmenorrhœa has failed to occur after relief to the tension of a superior or inferior rectus."

"So far as my experience goes, epilepsy very rarely results from simple conditions. The ocular anomalies in epilepsy are of the most complicated, and often of the most obscure character. A simple insufficiency may induce headache or other minor manifestations, but the ocular causes of epilepsy are usually of a character most perplexing to the surgeon, and sometimes of a character which cannot be completely remedied. Hence, great patience, and, in certain cases, much time and skill are required to accomplish that which can finally be done. If, in the meantime, the patient and his friends are constantly assured by both lay and professional advisers that his efforts must, of necessity, prove fruitless, he is apt to withdraw from treatment, even while defects which are of great importance, are known to exist, and which, by continued efforts, might be removed."

Prof. Ranney is authority for the statement that in cases of epilepsy of long duration under treatment directed to ocular difficulties, the affection has been scarcely less tractable than diseases commonly regarded as easily curable.

As furnishing a suggestion as to the possible method of production of epileptic attacks from eye-strain, it is interesting to note some experiments performed several years ago by Drs. Dercum, Parker, and others in the artificial induction of convulsive seizures. They found that it was possible to produce spasms in many persons by the following method:[1]

"The subject being seated, the tips of the fingers of one or both hands were so placed upon the surface of a table as to give merely a delicate sense

[1] See "Artificial Induction of Convulsive Seizures," by Drs. F. X. Dercum and A. J. Parker. Journal of Mental and Nervous Diseases, October, 1884.

of contact—*i. e.*, the fingers were not allowed to rest upon the table, but were maintained, by a constant muscular effort, barely in contact with it. Any other position involving a like effort of constant muscular adjustment was found to be equally efficient. Any one object in the room was now selected, and the mind fixed upon it, or some subject of thought was taken up and unswervingly followed.

"After the lapse of a variable period of time, extending from a few minutes to an hour, and depending upon individual peculiarities to be noted, ... the subject was frequently thrown violently to the ground in a general convulsion, preceded by tremors which rapidly became more violent.

"Seizures equalling in violence a general convulsion were by no means induced in all subjects, and were generally the result of experiments repeated many times during the same evening. In the experimenters the convulsions became so easily induced that it was thought advisable to desist for a long period."

The *effort of constant muscular adjustment* here spoken of appears not unlike the condition found in the eyes in cases of insufficiency of the ocular muscles; and it seems not unreasonable to infer that if such strain of the muscles of the forearm would produce results of the kind reported by the authors just named, that the strain upon ill-balanced ocular muscles (which must be continuous during the whole of the time that the eyes are opened) should be productive of even more serious, and, indeed, permanent results.

In the great majority of these cases there is but one satisfactory method of treatment, and that is graduated tenotomy. The operation consists in making a small opening through the conjunctiva, exactly over the insertion of the tendon, when the tendon is seized by extremely fine forceps and divided outwardly in each direction, preserving the extreme outer fibres, or, at least, the reflection of the capsule of Tenon, which serves as an auxiliary attachment. Tenotomies for strabismus and so-called partial tenotomies have, of course, long been made, but there are radical differences between these and the operation here described.

The fan-shaped expansion of the tendons of the recti at their points of insertion into the sclerotic are somewhat wider than is generally supposed, while the elasticity of their edges is an influential factor in determining a favorable result in the purpose of the operation—that is, in bringing about a relaxation which shall be permanent by permitting the divided portion to retract and form a new attachment to the globe further back.

The use of prisms as a means of treatment of marked heterophoria is not to be relied on; as in many cases they are found to be insuffi-

cient and disappointing.[1] They, however, have a certain value as means of systematic exercise of the ocular muscles, particularly in the milder cases.

When the correction is made by tenotomy, all that is necessary to be done in a given case should be regarded, in a sense, as one operation, though it may be in several stages and at different periods—as a watchmaker counts the regulating of the watch one operation, though he may be obliged to move the regulator a number of times; or as the correction of an astigmatism is one operation, though it may involve a number of sittings.

In one complicated case I have operated as many as seven times; the first operation nearly two years, and the last a week ago; the net result being an unquestionable gain both in head symptoms, which were at one time alarming, and in the severe asthenopia to which the patient had long been subject. Previous to the operation she had suffered from severe pain in the region of the eyes and in the back of the head, accompanied by general nervous distress of an entirely disabling character. An eminent ophthalmologist declared her to have organic disease at the base of the brain from the appearance of the eye ground. This was about three years ago. To-day this lady assured me that she felt "wonderfully better," and expressed her entire satisfaction with the treatment she had received.

It is to be reëmphasized in this connection, as an additional caution, that no operation is ever to be undertaken unless the indications for it are positively made out. From a perfectly plain case, evident to the merest tyro, to one demanding the greatest skill and patience of the most experienced, there is every gradation. Nothing would tend more to bring discredit upon the procedure than premature operations, which might result in such disturbance of the ocular muscles as seriously to cripple binocular vision without in the least alleviating the reflex condition for which the operation was undertaken.

Mrs. G. H. C., referred to me by Dr. W. H. H. Githens, aged thirty-two, married, mother of four children. Has suffered for many years from almost constant severe headache combined with a feeling of drowsiness, the seat of the pain being the brow and vertex. Eyeballs painful, always felt better when the eyes were closed. There is frequently double vision, but no manifest strabismus. General condition markedly neurasthenic. Although there was no error of refraction except a very slight amount of hyperopia shown

[1] Since this paper was written a physician of this city—himself an accomplished neurologist—who habitually wears spectacles for the correction of refractive errors and who also suffers from muscular faults, in a conversation with me, said with emphasis, "It is *impossible* for me to wear prisms. I have tried them thoroughly and know they would drive me crazy."

only under full mydriasis, the patient was unable to use her eyes at any near work, such as reading, sewing, etc., and at all times suffers from extreme intolerance of light. Ophthalmoscopic examination negative.

Muscular tests. The first examination showed an esophoria of nine degrees, which, under the use of partially correcting prisms worn for ten days, developed into settled fault of twenty degrees of esophoria and twenty-eight degrees esophoria in accommodation.

Tenotomy of the left internus relieved all the muscular fault except one degree, which I have allowed to remain. The relief of all symptoms was immediate and complete. The headache, the pain in the eyes, the intolerance of light, the drowsiness and double vision have all vanished. She is now able (without the aid of glasses) to read and sew as well as anyone, and threading a needle, which, previous to the operation, was almost an impossibility for her, is now done with facility. The general health and spirits have improved to a remarkable extent.

The photographs in her case are from untouched negatives, taken under photographic conditions as nearly identical as possible. The first photograph accurately represents her condition at the time of the operation. The strained look of the eyes, and the high condition of nervous tension are in no way exaggerated. The second photograph was taken one week after the operation, though it might, indeed, have been taken a day afterward—the immediate relief was so great. Perhaps no change in her condition is more marked than that of her tone of voice, which, from being high-pitched, nervous, almost wailing in character, has been moderated, mellowed, and vastly improved. The photograph of this case gives a clearer idea than words can do of the change which may be wrought by operation—in her case a single operation.

As additional graphic illustration of what may be accomplished, I pass around a few photogravure proofs belonging to Dr. Stevens, which he has very kindly placed at my disposal.

J. H. W., thoroughly healthy boy, without any nervous symptoms whatever, has been under my oversight since infancy. Except for a chronic tarsal ophthalmia there was nothing to call attention to the eyes. Very slight hypermetropia, for which I had prescribed glasses several years ago. On examination, three months ago there were eleven degrees of esophoria manifest, for which an operation was performed, removing seven degrees of the fault. Two weeks later four degrees additional were manifested; a week later the total manifest esophoria was nine degrees, when a second operation was performed, resulting in the removal of eight degrees of the nine then existing. A recent examination shows a manifest esophoria of three degrees, being a let-out of two degrees since the last operation.

From the first operation a marked change took place in his facial expression; his eyes, which had been previously been almost closed, opened widely, the tarsal ophthalmia showed prompt improvement, and he expressed himself free from a constant struggle to keep the eyes from closing, which he had not recognized as dependent upon any condition of his eyes until after it had been relieved.

I present the patient this evening for the purpose of demonstrating the amount of set-back given to the tendon, which, though invisible under ordinary circumstances, may be readily seen, upon causing either eye to be rolled outward, as a vertical line in each eye about two millimetres wide in one and a little less in the other, where the sclerotic is plainly visible through the conjunctiva.

Whether the claim made that the neuropathic predisposition is more frequently due to eye strain than to other conditions is fully justified by the facts or not, it is unnecessary at present to determine; seeing that enough is known to make it certain that eye strain from muscular fault is the cause of grave and varied reflex neuroses; and that in these cases carefully graduated tenotomy promises relief; beside there is in such cases always sufficient justification for the sake of the eyes and sight—apart from the nervous condition—for the correction of the fault.

My own experience covers many of these operations, performed for the relief of a variety of conditions, and notwithstanding serious difficulties at times encountered, I have a steadily increasing confidence in the legitimacy and value of the method.

1807 Chestnut Street.